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ESTIMATES OF MUNICIPAL AND INDUSTRIAL SALT LOADS

Introduction

The salinity (electrical conductivity, or EC) of the lower San Joaquin River (SJR) exceeds the maximum concentrations allowed in the Central Valley Regional Water Quality Control Board's (Regional Board) Water Quality Control Plan for the Sacramento River and San Joaquin River Basins (Basin Plan) (CVRWQCB, 1998). A reduction in salt loadings to the lower SJR is needed to bring it into compliance with the Basin Plan criteria. Salt loadings to the river come from sources such as irrigated agriculture, wetlands processes, and municipal and industrial (M&I) activities. The objective of this document is to present Regional Board staff estimations of salt loading to the lower SJR from M&I activities.

Methods

The sources of M&I salt loading include municipal, industrial, and domestic. The total salt loads generated and the amount of salt loads that directly enter the SJR (not land disposal) are quantified. Salt loads directly discharged to the SJR are determined for the irrigation (April through August) and non-irrigation seasons (September through March).

Sources of Salt Loading

Municipalities and Connected Industries

The eight municipalities (and their connected industries) that were accounted for in this study were Modesto, Merced, Turlock, Atwater, Patterson, Newman, Gustine, and Planada. Connected industries are those industries that discharge their wastewater into municipal wastewater treatment plants.

External Industries

There are 13 external industries accounted for in this report that are not connected to wastewater treatment plants and that have their own NPDES permits. These industries include San Joaquin Valley Dairymen, Huntsman Film, California Department of Fish & Game, Calaveras Trout Farm, Hershey, Hunt-Wesson, Sunseed Processor, and the City of Modesto Grayson reverse osmosis well. There are five groundwater pump-and-treat (hazardous waste cleanup) activities that are not industrial activities, but are grouped here for simplicity. These are the two General Electric cleanups, the U.S. Army Riverbank cleanup, the Stanislaus Farm Supply cleanup, and the Western Farm Service cleanup. The Castle AFB cleanup passes their effluent to the City of Atwater, so its salt loads are accounted for in Atwater's municipal data.

Domestic

Identifying the salt loads from domestic use of supply water gives an idea of the contributions to the overall salt loading. The personal use data can assist in differentiating the source of municipal salt loads, personal use or industries and commercial uses.

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Calculating Salt Loads

Flow rates and salt concentrations were calculated for external industries, municipalities, and personal use. Flow rates and salt concentrations for external industries and municipalities were determined from NPDES self-monitoring data, engineering reports, and personal conversations with plant operators and Regional Board staff. Information on personal use was determined using U.S. national averages of individual water use.

Results

Sources of Salt Loading

Municipalities and Connected Industries

The total municipal salt load generated by the eight municipalities (and their connected industries) located in the lower SJR is about 55,000 tons/year. The average annual flow rate from the municipalities sums to about 55 mgd (Table 1).

Table 1. Magnitude of Municipal Wastewater Effluent Flow Rates

Municipality	Effluent Flow Rate (mgd)[1]
Modesto	30.0
Turlock	11.4
Merced	7.1
Atwater	3.3
Newman	1.2
Gustine	0.8
Patterson	0.8
Planada	0.3
TOTAL	54.9

[1] Arithmetic yearly average flow rate of monthly average flow rates.

Direct Discharges To San Joaquin River Over Entire Year

Of the 55,000 tons/year of salt load generated by the eight municipalities (and their connected industries), about 25,500 tons/year are discharged directly into the San Joaquin River (solely by Modesto and Turlock). The remaining 30,000 tons/year of salt load are discharged to land irrigation or wetlands. The wastewater flow rate discharged to the San Joaquin River over the year averages to 25 mgd, with approximately 30 mgd from land irrigation or wetlands.

Direct Discharges to San Joaquin River During Irrigation and Non-Irrigation Seasons

Of the 25,500 tons/year of salt load that directly enters the lower SJR, 6,500 tons/year enters during the irrigation season and 19,000 tons/year enters during the non-irrigation season. Additional data is shown in Attachment A.

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External Industries

External industries not connected to municipal systems discharge about 7,000 tons of salt per year (Table 2). The average annual flow rate from these sources is about 11 mgd (not counting the high flow rates and low EC values from the Calaveras Trout Farm). The external industries were assumed to not directly discharge to the SJR.

Table 2. Salt Loads from External Industries

Industry	Flow Rate[1] (mgd)	Electrical Conductivity[1] (µmhos/cm)	Salt Load (tons/yr)
San Joaquin Valley Dairymen	0.2	1030	200
Huntsman Film Products	0.3	290	90
Combined GE Groundwater Cleanup	1.2	450	530
California Department of Fish and Game	2.0	50	100
Calaveras Trout Farm	27	40	1050
Hershey	3.0	260	760
Hunt-Wesson	2.0	1300	2530
Baltimore Aircoil	---	---	---
Del Mar Seed Processor (now Sunseed)	0.06	1000	60
Flowers Worm Farm[2]	N/A	N/A	N/A
U.S. Army Riverbank Cleanup	1.5	355	520
Stanislaus Farm Supply	0.22	1200	260
Western Farm Service, Vernalis	0.086	700	60
City of Modesto Grayson Well[3]	0.3	1950	560
TOTAL	10.9[4]		6720

[1] Values are approximate.
[2] This facility has not submitted their monitoring reports.
[3] Results from producing domestic water by electrodialysis.
[4] Does not include the Calaveras Trout Farm.

Personal Use

Personal use of domestic supply water contributes approximately 8,200 tons of salt per year to the lower SJR. The source water for these people, using the 60 gallons/person/day national average and the actual EC from each of the municipalities' source waters, results in another 7,800 tons/year. This sums to a total of 16,000 tons/year just from personal use.

This amounts to 29% of the actual 55,000 tons/year of the municipal load (with its connected industries), indicating that approximately 39,000 tons/year comes from the connected industries. It should be emphasized that these U.S. national average figures just give estimates for the Merced/Stanislaus municipalities of the production of salt loads through personal use. The calculated personal loads for each municipality are shown in Attachment A (and are called generic loads there).

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Usage Increase In EC

The increase in electrical conductivity (EC) between the source water to the communities and its wastewater varies quite a bit. This increase ranges from 250 µmhos/cm up to 3,360 µmhos/cm, as shown in Table 3.

Table 3. Municipal and Industrial Additions to Source Water Salinity

Municipality	Source Water Electrical Conductivity (µmhos/cm)	Wastewater Effluent Electrical Conductivity (µmhos/cm)	Increase in Electrical Conductivity (µmhos/cm)
Gustine	960	4320[3]	3360
Newman[1]	1550	2750	1200
Modesto[2]	280	1280[4]	1000
Patterson	1360	1980[3,5]	620
Turlock	510	810[4,5]	300
Merced	330	610[3,5]	280
Atwater	310	560[3,5]	250
Planada	N/A[6]	540[3]	N/A[6]

[1] Source water and wastewater effluent electrical conductivity from Carollo Engineers report, from personal communication with City of Newman.

[2] Modesto source water assumed to be one-half Modesto Irrigation District water (60 µmhos/cm) and one-half groundwater (525 µmhos/cm). The EC of the MID source water was after its salinity had been increased to minimize pipeline corrosion. The wastewater effluent EC represents October through May only, as EC values are not measured during June through September (not required by NPDES permit). The EC was measured at the oxidation pond prior to discharge into the SJR, and not at the wastewater treatment plant.

[3] The monthly EC values used in the calculations are from 1999.

[4] The average EC obtained was for 1995 through 1998.

[5] Flow-weighted from monthly data.

[6] A Planada representative phoned to say that they do not measure the EC or TDS of their source water.

Discussion

Portion Of Population

Not all of the municipal and industrial salt loads generated in the lower San Joaquin River area were accounted for in this study. The total population of Merced and Stanislaus Counties is 633,000 people (State Dept. of Finance, 1999). The eight municipalities above account for 342,000 people, or 54% of the total population.

Population Vs Salt Loading Relationships

There is no direct relationship between a municipality's population and its salt loads, probably as a result of the specific industries connected to each municipality. For example, Merced (population 62,000) has about ten times more population than Newman (population 6,025), yet Merced has a total salt load of 4,280 tons/year while Newman has a total salt load of 3,460 tons/year.

Effects Of Industrial Inputs

Metcalf and Eddy (3rd edition) states that personal use of water adds 150-380 mg/L TDS without considering industrial additions. If 265 mg/L TDS is considered to be the average, and the relationship EC = 0.65 x TDS is used, this gives a national average increase in EC of 408 µmhos/cm. (It is interesting to note that some future Regional

Board NPDES permits will allow an EC increase of "source water + 600" µmhos) Now, looking at Table 3, which shows data with industrial inputs included, one can say Atwater, Merced, Turlock, and Patterson are near or below the national average and therefore appear to have little industrial input. However, Modesto and Newman are two–three times this national average and thus reflect a sizeable input of industrial salts. Gustine is about eight times this national average and thus reflects a very large input of industrial salts.

Separating Personal Salt Contributions From Industrial Contributions

Utilization of the U.S. national averages can allow one to estimate the salt loads produced from personal use and that produced from industrial use (combining both connected industrial loads and external industrial loads). Use of the U.S. national averages estimates that 16,000 tons/year are from personal use. Adding the remainder of the 55,000 tons/year, which is 39,000 tons/year, to the 7,000 tons/year produced from external industrial loads gives an estimate of 46,000 tons/year coming from all industrial loads. So 16,000 tons/year is from personal use, and 46,000 tons/year is from industrial use (all sources).

Groundwater Input To Salt Loads

While it has been estimated here that 25,500 tons/year of salts directly enter the San Joaquin River, the remaining annual load of 36,500 tons/year (62,000 tons/year – 25,500 tons/year) may also be entering the river through groundwater inflow. A determination of groundwater flow direction and hydraulic conductivity will be needed in order to substantiate this assumption.

Data Availability And Assumptions

Sufficient data was available to allow for estimations of the salt loads. More time and site-specific knowledge would allow for refinements to the estimations. Conversions between EC and TDS used the relationship TDS = 0.65 x EC, which is only an approximate relationship.

References

Metcalf and Eddy, 1991. Wastewater Engineering, 3rd Edition.

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Attachment 1. Discharge of Municipal Salt Load (tons) to the San Joaquin River During Irrigation and Non-Irrigation Seasons and Annually

	IRRIGATION SEASON		NON-IRRIGATION SEASON		ANNUAL	
Municipality (population)	Salt Load Generated April - August (5-months)	Salt Load - Direct River Discharges[1]	Salt Load Generated Sept - March (7-months)	Salt Load - Direct River Discharges	Salt Load Generated	Salt Load - Direct River Discharges
Modesto (184,600)						
Real Data[2,3]	13,565[6]	3,163[7]	19,454[6]	14,134[7]	33,019[6]	17,297[7]
Generic[4,5]	3,105	1,242	4,347	3,726	7,452	4,968
Merced (62,800)						
Real Data	1,876	0	2,404	0	4,280	0
Generic[8]	1,245	0	1,743	0	2,988	0
Turlock (51,900)						
Real Data[7]	3,330	3,330	4,814	4,814	8,145	8,145
Generic[9]	1,000	1,000	1,400	1,400	2,400	2,400
Atwater (22,250)						
Real Data	744	0	1,062	0	1,810	0
Generic[10]	385	0	539	0	924	0
Patterson (10,400)						
Real Data	640	0	984	0	1,624	0
Generic	450	0	630	0	1,080	0
Newman (6,025)						
Real Data[11]	1,440	0	2,016	0	3,460	0
Generic	258	0	360	0	617	0
GUSTINE (4,280)						
Real Data	990	0	1,718	0	2,711	0
Generic	142	0	199	0	341	0
PLANADA						
Real Data	85	0	119	0	205	0

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Attachment 1 Notes:

[1] Direct discharge to the San Joaquin River only, it does not include land disposal (i.e., irrigation, wetlands, subsurface drains, etc.) that may eventually enter the river.
[2] Modesto cannot discharge to the river from June through September.
[3] This "real data" is used in the final determinations of salts to the river.
[4] Generic mean adds the national mean (Metcalf and Eddy text) of an additional 265 mg/L of TDS per person to the source water TDS. This represents domestic use without including industrial additions.
[5] Source water TDS obtained from Pat Ryan, Modesto Irrigation District and Lenora Hill, City of Modesto.
[6] Calculated from 1998 real data.
[7] Average of years 1995-1998.
[8] Source water TDS obtained from Debbie Livermore, City of Merced.
[9] Source water TDS obtained from Dan Madden, City of Turlock.
[10] Source water EC obtained from Monte Hammamoto, City of Atwater.
[11] Real data summary from Carollo Engineers report, from personal communication with City of Newman.

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Attachment 2. Estimation of Personal Salt Contributions Using U.S. National Averages[1]

1. Metcalf and Eddy, Table 2.1, shows that the typical municipal water use in the U.S. ranges from 40-130 gallons/person/day, and that the average is 60 gallons/person/day.

2. Metcalf and Eddy, Table 3.19, shows that the increase in TDS from domestic use ranges from 150-380 mg/L, but gives no average increase. Assume for the purposes of this calculation that the increase will be the average of this, or 265 mg/L. These values do not include commercial or industrial contributions.

3. Multiplying the 60 gallons/person/day times the 265 mg/L gives 0.132 pounds of salt/person/day.

4. Multiplying the 0.132 pounds of salt/person/day times the population of a given municipality yields the pounds of salt added to the source water for that municipality. For example, Turlock has a 1999 population of 51,900 people, so its salt load from personal use would be 6,850 pounds of salt per day.

5. To then obtain the salt loads produced from Turlock from the source water one would then multiply the 60 gallons/person/day times the TDS of the source water (250 mg/L in the case of Turlock), to arrive at 0.125 pounds of salt per person per day. Multiplying this figure by the 51,900 people in Turlock gives 6,487 pounds of salt per day.

6. Then, the total salts estimated to be produced by Turlock from personal use = salts produced from personal use + salts from the source water = 6,850 pounds/day + 6,487 pounds/day = 13,337 pounds/day, or 6.7 tons/day.

7. It must be recalled that this is the salt contribution solely from personal use of the source water, based solely on U.S. national averages. To it must be added the salt contributions from commercial and industrial uses of the water.

8. The advantage of using the above figures are that they give us a ballpark figure of the personal salt loads generated by the San Joaquin River municipalities if no other data is available. They also allow us to look at the data from the San Joaquin River municipalities, which contains salts from industrial sources as well as from personal use, and subtract out the estimations of personal amounts to get a ballpark figure of the amounts of salt input by the industries.

[1] Information obtained from Wastewater Engineering, Metcalf and Eddy, 3rd Edition, 1991.